left: Adding manure to the pits *(tassa)* before planting. (William Critchley)
right: Stone lines in combination with *tassa:* the two measures act together to capture runoff and improve plant performance. (Charles Bielders)

Planting pits and stone lines

Niger – *Tassa avec cordon pierreux*

Rehabilitation of degraded land through manured planting pits, in combination with contour stone lines. The planting pits are used for millet and sorghum production on gentle slopes.

The combination of planting pits *(tassa)* with stone lines is used for the rehabilitation of degraded, crusted land. This technology is mainly applied in semi-arid areas on sandy/loamy plains, often covered with a hard pan, and with slopes below 5%. These denuded plains are brought into crop cultivation by the combination of *tassa* and stone lines. Planting pits are holes of 20–30 cm diameter and 20–25 cm depth, spaced about 1 m apart in each direction. The excavated earth is formed into a small ridge downslope of the pit. Manure is added to each pit, but its availability is sometimes a problem. At the start of the rainy season, millet or sorghum is sown in these pits. The overall aim of the system is to capture and hold rainfall and runoff, and thereby improve water infiltration, while increasing nutrient availability.

Stone lines are small structures, at most three stones wide and sometimes only one stone high. The distance between the lines is a function of the slope and availability of stone. Typically they are sited 25–50 m apart on 2–5% slopes. Stones are usually collected from nearby sites – though sometimes up to 5–10 km away – and brought to the fields by donkey carts or lorries (when a project is involved). They are positioned manually, along the contour. Stone lines are intended to slow down runoff. They thereby increase the rate of infiltration, while simultaneously protecting the planting pits from sedimentation.

Often grass establishes between the stones, which helps increase infiltration further and accelerates the accumulation of fertile sediment. Wind-blown particles may also build up along the stone lines due to a local reduction in wind velocity. The accumulation of sediment along the stone lines in turn favours water infiltration on the upslope side. This then improves plant growth, which further enhances the effect of the system. Construction does not require heavy machinery (unless the stones need to be brought from afar by lorry).

The technique is therefore favourable to spontaneous adoption. Stone lines may need to be repaired annually, especially if heavy rains have occurred. Manure is placed every second (or third) year into the previously dug pits and sand is removed annually: normally the highest plant production is during the second year after manure application.

Location: Tahoua, Niger
Technology area: 40 km^2
SWC measure: structural
Land use: mixed (silvo-pastoral) and wasteland (before), cropland (after)
Climate: semi-arid
WOCAT database reference: QT NIG02
Related approach: Participatory land rehabilitation, QA NIG01
Compiled by: Oudou Noufou Adamou, Tahoua, Niger
Date: August 1999, updated June 2004

Editors' comments: The combination of planting pits and stone lines is becoming increasingly common throughout the West African Sahel. It is based on traditional methods, and was pioneered on the Central Plateau of Burkina Faso. It is best with application of manure or compost, and is thus most suitable to mixed farming systems. Stone lines are most appropriate when there is abundant loose stone close by: in flat stone-free areas planting pits may be used alone.

Classification

Land use problems

Soil fertility decline is the basic problem: this is due to degradation and nutrient mining. Loss of limited rainwater by runoff and loss of soil cover result in low crop production and food insufficiency. This occurs in combination with lack of pasture, resulting in shortage of manure.

Land use | **Climate** | **Degradation** | **SWC measures**

- silvo-pastoral: footslopes (before)
- wasteland: denuded, crusted plateaus (before)
- annual crops: millet and sorghum (after)
- semi-arid
- water erosion: loss of topsoil
- wind erosion: loss of topsoil
- physical: soil compaction/ crusting
- chemical: fertility decline
- structural: stone lines, planting pits
- agronomic: manure application (supp.)

Technical function/impact

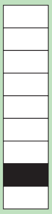
main:
- increase in infiltration
- increase/maintain water stored in soil
- water harvesting
- increase in organic matter
- increase in soil fertility
- increases natural regeneration of trees

secondary:
- reduction of slope length
- improvement of soil structure
- improvement of ground cover

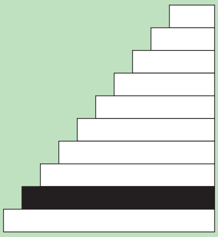
Environment

Natural environment

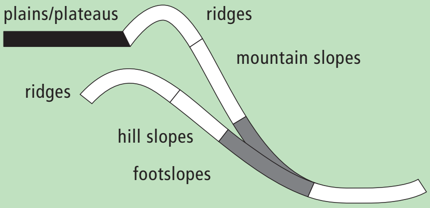
Average annual rainfall (mm)



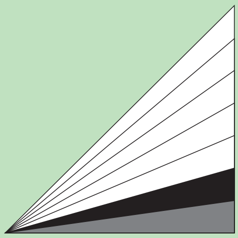
Altitude (m a.s.l.)



Landform



Slope (%)



Soil depth (cm)

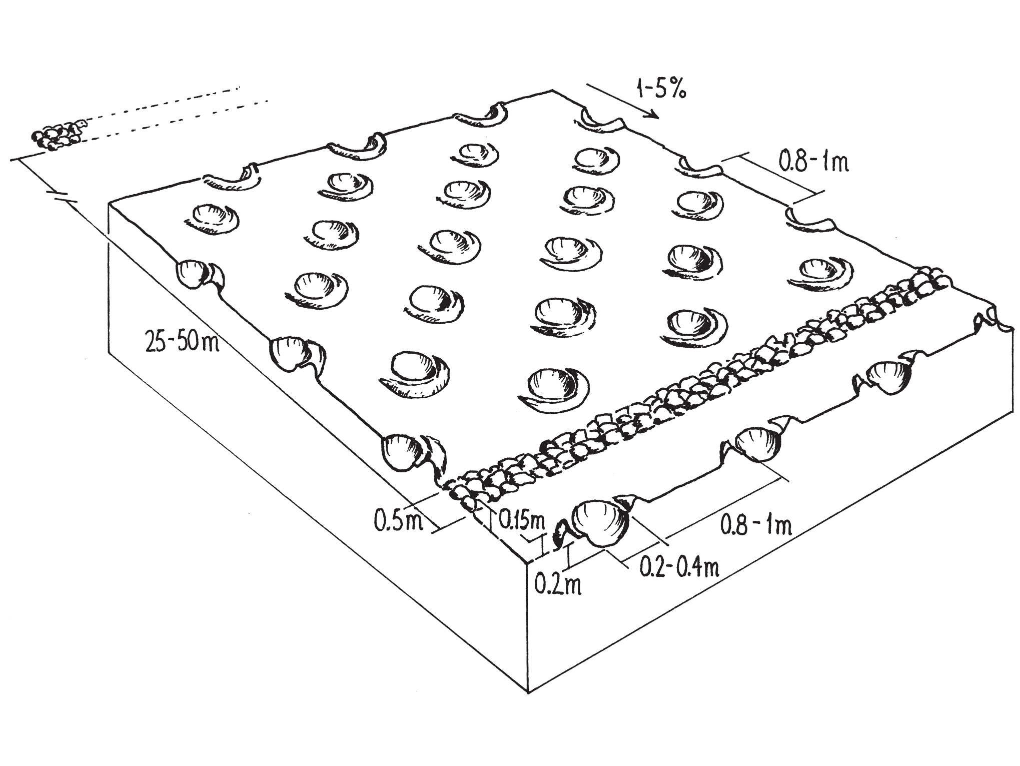
NB: soil properties before SWC

Growing season: 90 days (June to September)
Soil fertility: mostly low, partly very low
Soil texture: mainly coarse (sandy) partly medium (loam)
Surface stoniness: no loose stone on footslopes, some loose stone on plains
Topsoil organic matter: low (<1%)
Soil drainage: good, though infiltration is low where there is a crust
Soil erodibility: varied, depending on presence of surface crust

Human environment

Cropland per household (ha)

Land use rights: individual
Land ownership: mostly individual titled
Market orientation: mostly subsistence (self-supply), partly mixed (subsistence and commercial)
Level of technical knowledge required: field staff/extension worker: moderate, land user: low
Importance of off-farm income: >50% of all income: remittances from out-migration of labour, commerce and crafts



Technical drawing
Planting pits *(tassa)* capture rainfall runoff for cultivation of annual crops, and the stone lines – spaced at 25–50 metres apart – help hold back moisture and eroded soil.

Implementation activities, inputs and costs

Establishment activities

1. Digging pits *(tassa)* with a hoe in the dry season: the excavated earth forms ridges downslope of the hole. The pits are spaced about 1 m apart, giving approximately 10,000 pits/ha.
2. Digging out stones from nearby sites using a pick-axe and shovel.
3. Transporting stones with donkey cart or lorries.
4. Aligning the stones along the contour with the help of a 'water tube level': maximum of 3 stones wide.
5. Manuring the pits with approx 250 g per pit (2.5 t/ha).

All activities carried out in the dry season (November to May).
Duration of establishment: 1 year

Establishment inputs and costs per ha

Inputs	Costs (US$)	% met by land user
Labour for digging *tassa* (100 person days)	150	100%
Labour stone lines (25 person days)	40	100%
Equipment		
- Transporting stones with lorries 85–10 km)	40	0%
- Tools for *tassa*	5	100%
- Tools for stone lines	5	75%
Materials		
- Stone (50 m³)	0	
Agricultural		
- Compost/manure (2.5 t)	5	100%
TOTAL stone lines	**85**	**52%**
TOTAL *tassa*	**160**	**100%**
TOTAL stone lines and *tassa*	**245**	**83%**

Maintenance/recurrent activities

1. Removing sand from the *tassa* (annually, March–May).
2. Manuring the pits with about 250 g per pit (2.5 t/ha) every second year in October/November or March-May.
3. Check and repair stone lines annually and after heavy rains.

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US$)	% met by land user
Labour *tassa* (20 person days)	30	100%
Labour stone lines (1 person days)	1.5	100%
Equipment		
- Tools *tassa*	1	100%
Agricultural		
- Compost/manure (1.25 t)	2.5	100%
TOTAL	**35**	**100%**

Remarks: The costs are based on 300 m of stone lines per hectare (on a 3–4% slope). Maintenance costs refer to removing sand from the pits from the second year onwards, and to the application of manure every second year (costs are spread on an annual basis). If applicable, costs for transporting the manure need to be added. The general assumption in these calculations is that adequate manure is readily available close by. The availability of stones is the main factor in determining costs – though labour availability can affect prices also. If stones are not available in the field or nearby (from where they can be transported by donkey cart), they have to be carried by lorries, which is much more expensive. The costs here refer to fuel costs only, paid by a project: they do not include depreciation of lorries.

Assessment

Acceptance/adoption

All villagers accepted the technology with incentives of some hand tools and provision of transport for the collection of the stones (by lorries where necessary), which ensured a higher participation. There is moderate growing spontaneous adoption (for rehabilitation of the plains), but there are no estimates available regarding the extent.

Benefits/costs according to land user

Benefits compared with costs	short-term:	long-term:
establishment	positive	very positive
maintenance/recurrent	positive	very positive

Impacts of the technology

Production and socio-economic benefits

- +++ crop yield increase
- ++ farm income increase

Socio-cultural benefits

- ++ improved knowledge SWC/erosion
- + community institution strengthening through mutual aid in technology implementation

Ecological benefits

- ++ long-term soil cover improvement
- ++ increase in soil moisture
- ++ increase in soil fertility
- ++ increase in organic matter
- ++ soil loss reduction

Off-site benefits

- + reduced downstream flooding
- + reduced downstream siltation

Production and socio-economic disadvantages

- −− increased labour constraints
- −− increased input constraints

Socio-cultural disadvantages

- − land use rights conflicts of rehabilitated land
- − conflicts between farmers and pastoralists because pasture land is being turned into cultivated fields

Ecological disadvantages

- − waterlogging in planting pits after heavy rains

Off-site disadvantages

none

Concluding statements

Strengths and ➜ how to sustain/improve

Simple technology, individually applicable in the dry season, requiring only very little training/knowledge and no special equipment.

Making best use of manure, which is a limiting resource.

Increase in agricultural production.

Rehabilitation of degraded and denuded land: bringing back into production formerly uncultivated land; extension of farm land to the plateaus.

Weaknesses and ➜ how to overcome

Labour demanding technology for implementation and maintenance ➜ Mechanisation of tasks: transportation of stones and manure. However, this would raise the cost.

Instability of planting pits in loose soil, increased erosion on steeper slopes and with heavier rains ➜ Avoid loose sandy soils and steep slopes.

The effectiveness can be compromised if the various geo-morphological units (plateaus, slopes) are not treated simultaneously ➜ Catchment area approach if downstream flooding is an issue.

Possibility of land use conflicts concerning rehabilitated land, in particular with pastoralists ➜ Better coordination/consultation before implementing the technology in an area.

Implementation constraint: availability of manure and/or stones and transporting manure/stones to the plateaus and slopes ➜ Subsidise transport means (or supply donkey carts) or/and apply stone lines only in areas where there are stones available close to the fields.

Key reference(s): Bety A, Boubacar A, Frölich W, Garba A, Kriegl M, Mabrouk A, Noufou O, Thienel M and Wincker H (1997): *Gestion durable des ressources naturelles. Leçons tirées du savoir des paysans de l'Adar.* Ministère de l'agriculture et de l'élevage, Niamey, 142 pp. ■ Hassane A, Martin P and Reij C (2000) *Water harvesting, land rehabilitation and household food security in Niger: IFAD's Soil and Water Conservation Project in Illela District.* IFAD, Rome, 51 pp. ■ Mabrouk A, Tielkes E and Kriegl M (1998) Conservation des eaux et des sols: Leçons des connaissances traditionnelles de la région de Tahoua, Niger. In: Renard, G., Neef, A,. Becker, K. and Von Oppen, M. (eds). *Soil fertility management in West African land use systems.* Proceedings of the Regional Workshop, 4-8 March 1997, Niamey, Niger. Margraf Verlag. Weikersheim/Germany. pp. 469–473.

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